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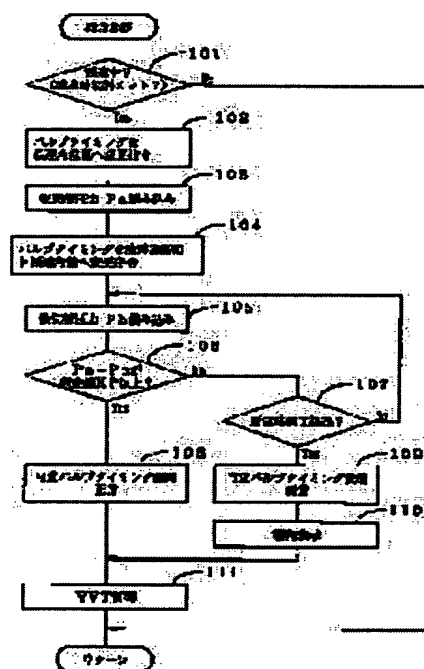
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(54) ABNORMALITY DIAGNOSTIC DEVICE OF VARIABLE VALVE SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To improve abnormality diagnostic precision of a variable valve timing mechanism and prevent deterioration of drivability and emission with compatibility.

SOLUTION: For example, whether an engine driving state is in the midway of deceleration or not is judged (step 101) as an abnormality diagnosis practice condition by taking notice of a fact that there is little influence on drivability and emission even when valve timing is forcibly changed at the time (during deceleration and acceleration) except for the time when an engine driving state is a steady state. Existence of abnormality of a variable valve timing mechanism is judged (steps 102-111) in accordance with whether variation of inlet pipe pressure at the time is higher than a judgement value or not by forcibly actuating the valve timing from the extreme delay angle position to a target spark-advance angle value for abnormality diagnosis when in the middle of deceleration. Consequently, it is possible to increase variation of inlet pipe pressure to use for abnormality judgement by setting the target spark-advance angle value for abnormality diagnosis without causing deterioration of drivability and emission at the time of abnormality diagnosis.



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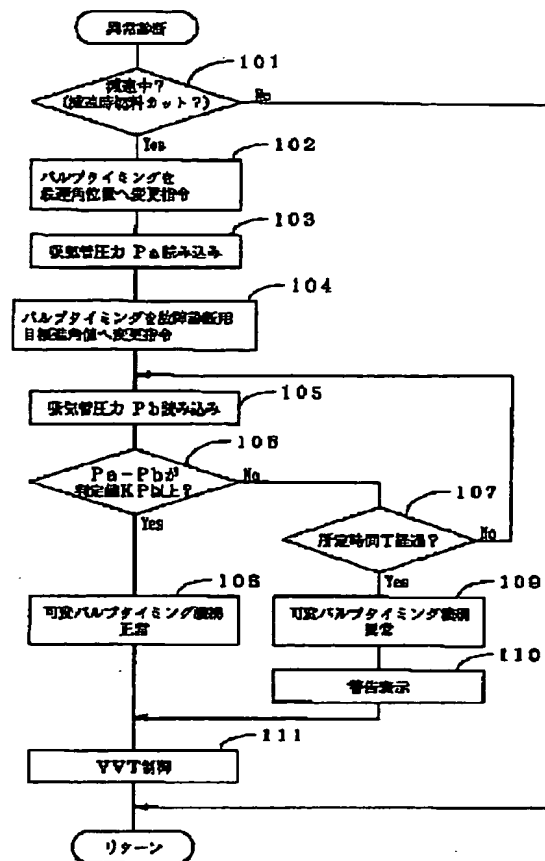
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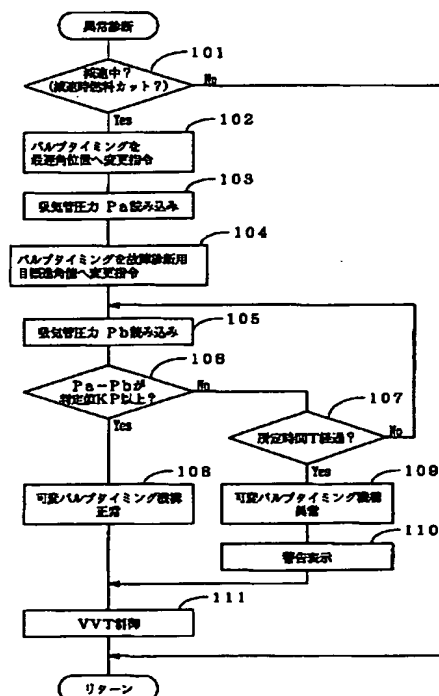
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(54) 【発明の名称】 可変バルブシステムの異常診断装置

(57) 【要約】

【課題】 可変バルブタイミング機構の異常診断精度向上とドライバビリティ・エミッション悪化防止とを両立させる。

【解決手段】 エンジン運転状態が定常状態以外の時(減速中や加速中)はバルブタイミングを強制的に変化させてもドライバビリティやエミッションに及ぼす影響が少ないことに着目し、異常診断実行条件として例えば減速中か否かを判定する(ステップ101)。減速中であれば、バルブタイミングを最速角位置から異常診断用の目標進角値に強制的に作動させ、そのときの吸気管圧力の変化量が判定値以上か否かで可変バルブタイミング機構の異常の有無を判定する(ステップ102～111)。これにより、異常診断時にドライバビリティやエミッションの悪化を招くことなく、異常診断用の目標進角値をある程度大きく設定して、異常判定に用いる吸気管圧力の変化量を大きくすることができる。



【特許請求の範囲】

【請求項 1】 内燃機関のバルブタイミング又はバルブリフト量を可変制御する可変バルブ機構と、

前記内燃機関の吸入空気量又は吸気管圧力を検出する吸気パラメータ検出手段と、

前記可変バルブ機構を異常診断用の制御値を用いて強制的に作動させたときの前記吸気パラメータ検出手段の検出値の変化に基づいて前記可変バルブ機構の異常診断を実行する異常診断手段とを備え、

前記異常診断手段は、前記内燃機関の運転状態が定常状態以外のときに異常診断を実行することを特徴とする可変バルブシステムの異常診断装置。

【請求項 2】 内燃機関のバルブタイミングを可変制御する可変バルブタイミング機構と、

前記内燃機関のバルブリフト量を可変制御する可変バルブリフト機構と、

前記内燃機関の吸入空気量又は吸気管圧力を検出する吸気パラメータ検出手段と、

前記可変バルブタイミング機構と前記可変バルブリフト機構のうちの一方の機構を固定し、他方の機構を異常診断用の制御値を用いて強制的に作動させたときの前記吸気パラメータ検出手段の検出値の変化に基づいて当該他方の機構の異常診断を実行する異常診断手段とを備えていることを特徴とする可変バルブシステムの異常診断装置。

【請求項 3】 内燃機関の吸気バルブのバルブタイミングとバルブリフト量の少なくとも一方を可変制御する吸気側可変バルブ機構と、

前記内燃機関の排気バルブのバルブタイミングとバルブリフト量の少なくとも一方を可変制御する排気側可変バルブ機構と、

前記内燃機関の吸入空気量又は吸気管圧力を検出する吸気パラメータ検出手段と、

前記吸気側可変バルブ機構と前記排気側可変バルブ機構のうちの一方の可変バルブ機構を固定し、他方の可変バルブ機構を異常診断用の制御値を用いて強制的に作動させたときの前記吸気パラメータ検出手段の検出値の変化に基づいて当該他方の可変バルブ機構の異常診断を実行する異常診断手段とを備えていることを特徴とする可変バルブシステムの異常診断装置。

【請求項 4】 前記異常診断手段は、前記内燃機関の運転状態が定常状態以外のときに異常診断を実行することを特徴とする請求項 2 又は 3 に記載の可変バルブシステムの異常診断装置。

【請求項 5】 V 型内燃機関の左右バンクにそれぞれ設けられた可変バルブ機構と、

前記内燃機関の吸入空気量又は吸気管圧力を検出する吸気パラメータ検出手段と、

前記左右バンクのうちの一方のバンクの可変バルブ機構を固定し、他方のバンクの可変バルブ機構を異常診断用

の制御値を用いて強制的に作動させたときの前記吸気パラメータ検出手段の検出値の変化に基づいて当該他方のバンクの可変バルブ機構の異常診断を実行する異常診断手段とを備えていることを特徴とする可変バルブシステムの異常診断装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、内燃機関のバルブタイミングとバルブリフト量の少なくとも一方を可変制御する可変バルブ機構の異常の有無を診断する可変バルブシステムの異常診断装置に関するものである。

【0002】

【従来の技術】近年、車両に搭載される内燃機関においては、出力向上、燃費節減、排気エミッション低減を目的として、可変バルブタイミング機構を採用したものが増加しつつある。そして、この可変バルブタイミング機構の異常診断のために、特開平 6-317118 号公報に示すように、エンジン運転状態が低回転（1500～2000rpm）かつ低負荷でほぼ一定となる定常状態のときに、バルブタイミングを強制的に変化させ、そのときの吸入空気量の変化量を検出し、この吸入空気量変化量を判定値と比較して可変バルブタイミング機構の異常の有無を診断するようにしたものがある。

【0003】

【発明が解決しようとする課題】上記公報では、エンジン運転状態がほぼ一定の定常状態のときにバルブタイミングを強制的に変化させて吸入空気量の変化量から異常診断を行うようにしているが、定常状態のときに強制的に吸入空気量を変化させることは、それまで安定していたエンジン運転状態を強制的に過渡状態に変化させることを意味し、ドライバビリティやエミッションの悪化を招くことになる。かといって、異常診断時のドライバビリティやエミッションの悪化を少なくするために、バルブタイミングの変化量（吸入空気量の変化）を少なくすれば、正常時と異常時の差が小さくなり、異常診断を精度良く行うことができない。従って、異常診断精度を良くするには、バルブタイミングの変化量（吸入空気量の変化）をある程度大きくする必要がある。

【0004】近年、一部の車種では、バルブリフト量を可変する可変バルブリフト機構を採用したものがあるが、この可変バルブリフト機構についても、事情は変わらず、異常診断時のドライバビリティやエミッションへの影響を少なくするために吸入空気量の変化を少なくすれば、異常診断を精度良く行うことができない。以下の説明では、可変バルブタイミング機構と可変バルブリフト機構とを総称して「可変バルブ機構」という。

【0005】また、最近では、吸気側と排気側の両方に可変バルブタイミング機構を搭載したエンジンや、可変バルブタイミング機構と可変バルブリフト機構の両方を搭載したエンジンが考えられている。これらのエンジン

でも、吸入空気量の変化から異常診断を行うことが考えられるが、一方の可変バルブ機構の異常診断を行っているときに、他方の可変バルブ機構が作動していると、当該他方の可変バルブ機構の作動によって吸入空気量に変化してしまい、正確な異常診断を行うことができない。

【0006】本発明はこれらの事情を考慮してなされたものであり、第1の目的は、吸入空気量等の吸気パラメータの変化に基づいて可変バルブ機構の異常診断を行うシステムにおいて、ドライバビリティやエミッションへの影響を少なくしながら、異常診断を精度良く行うことができる可変バルブシステムの異常診断装置を提供することにあり、また、第2の目的は、複数の可変バルブ機構を搭載した内燃機関において、吸入空気量等の吸気パラメータの変化に基づいて可変バルブ機構の異常診断を精度良く行うことができる可変バルブシステムの異常診断装置を提供することにある。

【0007】

【課題を解決するための手段】上記目的を達成するために、本発明の請求項1の可変バルブシステムの異常診断装置は、内燃機関のバルブタイミング又はバルブリフト量を可変制御する可変バルブ機構を備え、内燃機関の吸入空気量又は吸気管圧力を吸気パラメータ検出手段により検出すると共に、可変バルブ機構を異常診断用の制御値を用いて強制的に作動させたときの吸気パラメータ検出手段の検出値（吸入空気量又は吸気管圧力）の変化に基づいて可変バルブ機構の異常の有無を異常診断手段により診断する。この際、異常診断手段は内燃機関の運転状態が定常状態以外にときに異常診断を実行する。

【0008】運転状態が定常状態以外にとき、例えば、加速状態や減速状態のような過渡状態のときは、運転状態に応じて吸気パラメータ（吸入空気量、吸気管圧力）も変化するため、この期間に、異常診断のために更に吸気パラメータを変化させても、従来のように定常状態から吸気パラメータを変化させる場合と比較して、ドライバビリティやエミッションへの影響が少ない。従って、運転状態が定常状態以外にときに異常診断を行えば、ドライバビリティやエミッションへの影響を少なくしながら、異常診断時のバルブタイミング又はバルブリフト量の変化量のある程度大きくして、異常診断に用いる吸気パラメータの変化を大きくすることができ、異常診断精度向上とドライバビリティ・エミッション悪化防止とを両立させることができる。

【0009】また、請求項2のように、可変バルブタイミング機構と可変バルブリフト機構の両方を備えた内燃機関において、吸気パラメータの変化に基づいて異常診断を行う場合には、可変バルブタイミング機構と可変バルブリフト機構のうちの一方の機構を固定し、他方の機構を診断用制御値を用いて強制的に作動させたときの吸気パラメータの変化に基づいて当該他方の機構の異常診断を行うようにすると良い。このようにすれば、可変バ

ルブタイミング機構と可変バルブリフト機構の両方を備えた内燃機関において、異常診断しない側の可変バルブ機構の作動による吸気パラメータの変化を無くして、異常診断する側の可変バルブ機構の作動による吸気パラメータの変化のみを取り出すことができ、異常診断しない側の可変バルブ機構の影響を全く受けずに、異常診断を精度良く行うことができる。

【0010】また、請求項3のように、吸気バルブと排気バルブの両方に可変バルブ機構（可変バルブタイミング機構及び／又は可変バルブリフト機構）を備えた内燃機関において、吸気パラメータの変化に基づいて異常診断を行う場合には、吸気側可変バルブ機構と排気側可変バルブ機構のうちの一方の可変バルブ機構を固定し、他方の可変バルブ機構を診断用制御値を用いて強制的に作動させたときの吸気パラメータの変化に基づいて当該他方のバルブ機構の異常診断を行うようにすると良い。このようにすれば、吸気バルブと排気バルブの両方に可変バルブ機構を備えた内燃機関において、異常診断しないバルブ側の可変バルブ機構の作動による吸気パラメータの変化を無くして、異常診断するバルブ側の可変バルブ機構の作動による吸気パラメータの変化のみを取り出すことができ、異常診断しないバルブ側の可変バルブ機構の影響を全く受けずに、異常診断を精度良く行うことができる。

【0011】更に、上述した請求項2、3のように複数の可変バルブ機構を搭載した内燃機関においても、請求項4のように、内燃機関の運転状態が定常状態以外にときに可変バルブ機構の異常診断を行うことが好ましい。このようにすれば、前述した請求項1と同じく、異常診断時のドライバビリティ・エミッションの悪化防止と異常診断精度向上とを両立させることができる。

【0012】また、V型内燃機関の左右バンクにそれぞれ可変バルブ機構を設けた可変バルブシステムにおいては、請求項5のように、左右バンクのうちの一方のバンクの可変バルブ機構を固定し、他方のバンクの可変バルブ機構を異常診断用の制御値を用いて強制的に作動させたときの吸気パラメータ検出手段の検出値の変化に基づいて当該他方のバンクの可変バルブ機構の異常診断を実行するようにすると良い。このようにすれば、V型内燃機関の左右バンクにそれぞれ可変バルブ機構を設けた可変バルブシステムにおいて、異常診断しないバンク側の可変バルブ機構の作動による吸気パラメータの変化を無くして、異常診断するバンク側の可変バルブ機構の作動による吸気パラメータの変化のみを取り出すことができ、異常診断しないバンク側の可変バルブ機構の影響を全く受けずに、異常診断を精度良く行うことができる。

【0013】

【発明の実施の形態】 [実施形態(1)] 以下、本発明の実施形態(1)を図1及び図2に基づいて説明する。まず、図1に基づいてシステム全体の概略構成を説明す

る。内燃機関であるエンジン 11 は、DOHC エンジンであり、クランク軸 12 の動力をタイミングチェーン（図示せず）を介して吸気カム軸 13 と排気カム軸 14 とに伝達し、各カム軸 13, 14 によって吸気バルブ 15 と排気バルブ 16 を開閉駆動するようになっている。吸気カム軸 13 には、クランク軸 12 に対する吸気カム軸 13 の進角量を調整する油圧駆動式の変換バルブタイミング機構 17 が設けられている。また、吸気カム軸 13 の近傍にはカム軸センサ 23 が設置され、クランク軸 12 の近傍にはクランク軸センサ 24 が設置されている。

【0014】この場合、クランク軸センサ 24 は、クランク軸 12 の 1 回転当たり N 個のクランク軸位相検出パルス信号を発生するのに対し、カム軸センサ 23 は、吸気カム軸 13 の 1 回転当たり $2N$ 個のカム軸位相検出パルス信号を発生する。また、吸気カム軸 13 の最大進角量を θ_{max} °A とした場合、 $N < 360 / \theta_{max}$ となるようにクランク軸位相検出パルス信号数 N が設定されている。これによって、クランク軸センサ 24 からのクランク軸位相検出パルス信号と、これに続いて発生する吸気カム軸センサ 23 からのカム軸位相検出パルス信号との間の相対回転角により吸気バルブ 15 の実バルブタイミング（吸気カム軸 13 の実進角量）が算出される。

【0015】また、エンジン 11 のシリンダブロック 11a には、冷却水温を検出する冷却水温センサ 25 が取り付けられ、シリンダヘッド 11b には、気筒毎に点火プラグ 26 が取り付けられている。

【0016】一方、吸気管 27 の最上流部には、エアクリーナ 28 が設けられ、その下流側には、吸入空気量を検出するエアフローメータ 29 が設けられている。このエアフローメータ 29 の下流側には、スロットルバルブ 30 が設けられ、このスロットルバルブ 30 の開度（スロットル開度）がスロットルセンサ 31 によって検出される。このスロットルバルブ 30 の下流側には、吸気管圧力を検出する吸気管圧力センサ 32 が設けられている。また、各気筒の吸気ポート 33 の近傍には、燃料噴射弁 34 が取り付けられている。

【0017】上述した各種のセンサの出力は、エンジン制御回路（以下「ECU」と表記する）36 に入力される。この ECU 36 はマイクロコンピュータを主体として構成され、クランク軸センサ 24 及びカム軸センサ 23 からの検出パルス信号に基づいて吸気バルブ 15 の実バルブタイミングを演算すると共に、エンジン運転状態を検出する各種センサ出力に基づいて吸気バルブ 15 の目標バルブタイミング（吸気カム軸 13 の目標進角量）を演算する。

【0018】また、ECU 36 は、吸気バルブ 15 の実バルブタイミングを目標バルブタイミングに一致させるように油圧制御弁（図示せず）を制御して可変バルブ

タイミング機構 17 をフィードバック制御する可変バルブタイミング制御（以下「VVT 制御」と表記する）を行う。

【0019】更に、ECU 36 は、図 2 に示す異常診断プログラムを所定時間毎に実行することで、定常状態以外の時、例えば減速中に可変バルブタイミング機構 17 の異常診断を行う異常診断手段として機能する。以下、図 2 の異常診断プログラムの処理内容を説明する。本プログラムが起動されると、まずステップ 101 で、異常診断実行条件として減速中か否かを判定する。この判定は、例えば、減速時燃料カット中か否かにより判定する。もし、ステップ 101 で、減速中でないと判定されれば、異常診断実行条件が不成立となり、以降の異常診断処理（ステップ 102 ~ 111）を行わずに、本プログラムを終了する。

【0020】一方、ステップ 101 で減速中と判定された場合には、異常診断実行条件が成立し、バルブタイミングを強制的に変化させてもドライバビリティやエミッションに及ぼす影響が少ないと判断して、ステップ 102 以降の異常診断処理を次のようにして実施する。

【0021】まず、ステップ 102 で、吸気バルブ 15 のバルブタイミングを強制的に最遅角位置に戻し、次のステップ 103 で、吸気管圧力センサ 32 の検出信号から吸気バルブ 15 のバルブタイミングが最遅角位置にあるときの吸気管圧力 P_a を読み込む。この場合、吸気管圧力センサ 32 が特許請求の範囲でいう吸気パラメータ検出手段として機能する。

【0022】その後、ステップ 104 で、吸気バルブ 15 のバルブタイミングを異常診断用の目標進角値まで強制的に進角制御して、吸気管圧力を変化させる。この後、ステップ 105 で、吸気管圧力センサ 32 で検出した吸気管圧力 P_b を読み込み、次のステップ 106 で、吸気管圧力の変化量（ $P_a - P_b$ ）が判定値 KP 以上であるか否かを判定する。この際、判定値 KP は予め設定された固定値を用いても良いし、エンジン運転状態に応じてマップ又は関数式により判定値 KP を設定しても良い。

【0023】もし、吸気管圧力の変化量（ $P_a - P_b$ ）が判定値 KP よりも小さければ、ステップ 107 に進み、所定時間 T が経過したか否かを判定する。ここで、所定時間 T は、正常時の可変バルブタイミング機構 17 の作動遅れを考慮するために、バルブタイミングの目標進角値への変更を指令してから吸気管圧力の変化量（ $P_a - P_b$ ）が判定値 KP 以上になるまでの正常時の最大時間よりも若干長い時間に設定されている。従って、可変バルブタイミング機構 17 が正常であれば、所定時間 T 以内に吸気管圧力の変化量（ $P_a - P_b$ ）が判定値 KP 以上となる。

【0024】所定時間 T 経過前は、吸気管圧力の変化量（ $P_a - P_b$ ）が判定値 KP より小さいと判定される毎

に、上述したステップ105、106の処理を繰り返して実行する。そして、所定時間Tが経過するまでに、ステップ106で、吸気管圧力の変化量($P_a - P_b$)が判定値KP以上になったと判定されれば、ステップ108に進み、可変バルブタイミング機構17が正常であると判定し、ステップ111に進み、通常のVVT制御に戻して、本プログラムを終了する。

【0025】一方、ステップ106で吸気管圧力の変化量($P_a - P_b$)が所定値KP以上と判定されことなく、所定時間Tが経過した場合は、可変バルブタイミング機構17が正常に作動していないと判断して、ステップ109に進み、可変バルブタイミング機構17の異常と判定する。この場合は、次のステップ110で、警告ランプ(図示せず)を点灯又は点滅させて、運転者に可変バルブタイミング機構17の異常を知らせた後、ステップ111に進み、通常のVVT制御に戻して本プログラムを終了する。

【0026】以上説明した実施形態(1)によれば、減速中は、バルブタイミングを強制的に変化させてもドライバビリティやエミッションに及ぼす影響が少ないという点に着目し、減速中に異常診断を行うようにしたので、異常診断時にドライバビリティやエミッションの悪化を招くことなく、異常診断用の目標進角値をある程度大きく設定して、異常診断に用いる吸気管圧力の変化量を大きくすることができ、正常時と異常時の吸気管圧力の変化量の差を大きくすることができる。これにより、異常診断時のドライバビリティ・エミッションの悪化を防止しながら、異常診断精度を向上させることができる。

【0027】また、本実施形態(1)では、減速中は、吸気管圧力の方が吸入空気量よりもバルブタイミング変化の影響を受けやすく、変化量が大きくなることに着目し、吸気管圧力の変化量を異常診断用の吸気パラメータとして用いるため、正常時と異常時の吸気管圧力の変化量の差をより大きくすることができ、異常診断をより精度良く実施することができる。

【0028】但し、本発明は、吸気管圧力に代えて、吸入空気量の変化量を異常診断用の吸気パラメータとして用いるようにしても良く、この場合でも、減速中に異常診断を行えば、ドライバビリティやエミッションの悪化を招くことなく、異常診断用の目標進角値をある程度大きく設定できるため、異常診断を行うのに必要な吸入空気量の変化量を得ることができる。

【0029】尚、本実施形態(1)では、減速中の判定を、減速時燃料カット中か否かにより判定するようにしたが、アクセル開度の減少量、スロットル開度の減少量、燃料噴射量の減少量等に基づいて判定するようにしても良い。

【0030】[実施形態(2)] 上記実施形態(1)では、減速中に異常診断を行うようにしたが、図3に示す

本発明の実施形態(2)では、加速中にバルブタイミングを強制的に変化させてもドライバビリティやエミッションに及ぼす影響が少ないことに着目し、加速中に異常診断を行うようにしている。更に、本実施形態(2)では、加速中は、吸入空気量の方が吸気管圧力よりもバルブタイミング変化の影響を受けやすく、変化量が大きくなることに着目し、異常診断用の吸気パラメータとして吸入空気量の変化量を用いている。

【0031】本実施形態(2)で実行する図3の異常診断プログラムでは、まず、ステップ101aで、異常診断実行条件として加速中か否かを判定する。この判定は、例えば、アクセル開度の増加量、スロットル開度の増加量、燃料噴射量の増加量等に基づいて判定する。

【0032】ステップ101aで加速中(異常診断実行条件成立)と判定された場合には、バルブタイミングを強制的に変化させてもドライバビリティやエミッションに及ぼす影響が少ないと判断して、ステップ102、103aと進み、エアフローメータ29の検出信号から吸気バルブ15のバルブタイミングを最遅角位置に戻したときの吸入空気量 G_a を読み込む。この場合、エアフローメータ29が特許請求の範囲でいう吸気パラメータ検出手段として機能する。

【0033】その後、ステップ104で、吸気バルブ15のバルブタイミングを異常診断用の目標進角値まで強制的に進角制御して、吸入空気量を変化させ、次のステップ105aで、エアフローメータ29で検出した吸入空気量 G_b を読み込む。この後、ステップ106aで、吸入空気量の変化量($G_a - G_b$)が判定値KG以上か否かを判定する。

【0034】そして、所定時間T経過するまでに、吸入空気量の変化量($G_a - G_b$)が判定値KG以上となれば、可変バルブタイミング機構17が正常であると判定して通常のVVT制御に戻し、吸入空気量の変化量($G_a - G_b$)が判定値KG以上となることなく、所定時間Tが経過した場合は、可変バルブタイミング機構17の異常と判定し、警告表示して通常のVVT制御に戻す(ステップ107~111)。

【0035】以上説明した本実施形態(2)においても、前記実施形態(1)と同様の効果を得ることができる。尚、上記実施形態(2)では、異常診断用の吸気パラメータとして吸入空気量の変化量を用いたが、吸気管圧力の変化量を用いても良い。

【0036】また、上記各実施形態(1)、(2)は、本発明を吸気バルブ15の可変バルブタイミング機構17の異常診断に適用したものであるが、本発明は、排気バルブの可変バルブタイミング機構や、吸気バルブ又は排気バルブのリフト量を変更する可変バルブリフト機構の異常診断に適用しても良い。

【0037】[実施形態(3)] 次に、本発明の実施形態(3)を図4を用いて説明する。本実施形態(3)で

は、前記実施形態(1)のシステム構成に加えて、吸気バルブ15のリフト量を調整する可変バルブリフト機構(図示せず)が設けられている。

【0038】このように、1つの吸気バルブ15に対して可変バルブタイミング機構17と可変バルブリフト機構の両方を備えたシステムにおいて、吸入空気量や吸気管圧の変化に基づいて異常診断を行う場合、例えば、可変バルブリフト機構を異常診断用の目標リフト値まで強制的にリフト制御しても、可変バルブタイミング機構17が作動していると、その影響で吸入空気量や吸気管圧力が変動してしまい、正確な異常診断をすることができない。

【0039】そこで、本実施形態(3)では、図4に示す異常診断プログラムを所定時間毎に実行することで、可変バルブタイミング機構17と可変バルブリフト機構を備えたシステムにおける可変バルブリフト機構の異常診断を次のようにして行う。

【0040】まず、ステップ201で、可変バルブリフト機構の異常診断要求が有るか否かを判定し、可変バルブリフト機構の異常診断要求が無ければ、本プログラムを終了する。その後、可変バルブリフト機構の異常診断要求が発生した時に、ステップ202に進み、異常診断しない可変バルブタイミング機構17を現在の進角値に固定して、可変バルブタイミング機構17の作動による吸入空気量や吸気管圧力の変動を無くす。

【0041】その後、ステップ203に進み、可変バルブリフト機構の異常診断を実行する。この異常診断は、例えば、吸気バルブ15のリフト量を異常診断用の目標リフト値まで強制的に変化させ、そのときの吸入空気量又は吸気管圧力の変化量を異常判定値と比較することにより異常の有無を判定する。異常判定後、ステップ204に進み、異常診断を終了して可変バルブリフト機構を通常制御に戻し、次のステップ205で、可変バルブタイミング機構17の固定を解除して通常のVVT制御に戻し、本プログラムを終了する。

【0042】このようにすれば、異常診断しない可変バルブタイミング機構17の作動による吸入空気量や吸気管圧力の変動を無くして、異常診断する可変バルブリフト機構の作動のみを反映した吸入空気量又は吸気管圧力の変化量に基づいて異常診断をすることができる。この結果、可変バルブタイミング機構17と可変バルブリフト機構の両方を備えたシステムにおいて、精度の良い異常診断を行うことが可能となる。

【0043】尚、可変バルブタイミング機構17の異常診断を行う場合は、可変バルブリフト機構を固定するようにすれば良い。また、上記実施形態(3)では、吸気バルブ15に可変バルブタイミング機構17と可変バルブリフト機構の両方を備えたシステムに本発明を適用したが、排気バルブ16に可変バルブタイミング機構と可変バルブリフト機構の両方を備えたシステムにも適用可

能である。

【0044】[実施形態(4)]次に、本発明の実施形態(4)を図5を用いて説明する。本実施形態(4)では、前記実施形態(1)のシステム構成に加えて、排気バルブ16のバルブタイミングを変更する排気側可変バルブタイミング機構(図示せず)が設けられている。

【0045】吸気バルブ15と排気バルブ16の両方に可変バルブタイミング機構を備えたシステムにおいても、吸入空気量や吸気管圧の変化に基づいて異常診断を行う場合、異常診断しないバルブ側の可変バルブタイミング機構が作動していると、その影響で吸入空気量や吸気管圧力が変動してしまい、正確な異常診断をすることができない。

【0046】そこで、本実施形態(4)では、図5に示す異常診断プログラムを所定時間毎に実行することで、吸気バルブ15と排気バルブ16の両方に可変バルブタイミング機構を備えたシステムにおける異常診断を次のようにして行う。

【0047】まず、ステップ301で、吸気側可変バルブタイミング機構17の異常診断要求が有るか否かを判定し、吸気側可変バルブタイミング機構17の異常診断要求があれば、ステップ302に進み、異常診断しない排気側可変バルブタイミング機構を固定して、排気側可変バルブタイミング機構の作動による吸入空気量や吸気管圧力の変動を無くし、次のステップ303で、吸気側可変バルブタイミング機構17の異常診断を実行する。この異常診断は、前記実施形態(1)又は(2)と同じく、吸気側可変バルブタイミング機構17を最遅角位置から異常診断用の目標進角値まで強制的に進角させたときの吸入空気量の変化又は吸気管圧の変化に基づいて異常診断を行う。異常判定後、ステップ304に進み、異常診断を終了して吸気側可変バルブタイミング機構17を通常のVVT制御に戻し、次のステップ305で、排気側可変バルブタイミング機構の固定を解除して通常のVVT制御に戻し、本プログラムを終了する。

【0048】一方、ステップ301で、吸気側可変バルブリフト機構17の異常診断要求が無ければ、ステップ306に進み、排気側可変バルブタイミング機構の異常診断要求が有るか否かを判定する。排気側可変バルブタイミング機構の異常診断要求があれば、異常診断しない吸気側可変バルブタイミング機構17を固定して、吸気側可変バルブタイミング機構17の作動による吸入空気量や吸気管圧力の変動を無くす(ステップ307)。その後、吸気側と同じ方法で排気側可変バルブタイミング機構の異常診断を実行し(ステップ308)、異常判定後、異常診断を終了して排気側可変バルブタイミング機構を通常のVVT制御に戻し(ステップ309)、吸気側可変バルブタイミング機構17の固定を解除して通常のVVT制御に戻し(ステップ310)、本プログラムを終了する。

【0049】このようにすれば、異常診断しないバルブ側の可変バルブタイミング機構の作動による吸入空気量や吸気管圧力の変動を無くして、異常診断するバルブ側の可変バルブタイミング機構の作動のみを反映した吸入空気量の変化量又は吸気管圧力の変化量に基づいて異常診断を行うことができ、吸気バルブと排気バルブの両方に可変バルブ機構を備えたシステムにおいても、精度の良い異常診断を行うことが可能となる。

【0050】尚、上記実施形態(4)では、吸気バルブ15と排気バルブ16に可変バルブタイミング機構を備えたシステムに本発明を適用したが、吸気バルブ15と排気バルブ16に可変バルブタイミング機構及び/又は可変バルブリフト機構を備えたシステムにも適用可能である。

【0051】また、前記実施形態(3)、(4)の異常診断を、前記実施形態(1)、(2)と同じく、定常状態以外の時(加速中、減速中)に実施するようにしても良い。このようにすれば、異常診断時のドライバビリティやエミッションも向上することができる。

【0052】[実施形態(5)]次に、本発明の実施形態(5)を図6を用いて説明する。本実施形態(5)は、V型内燃機関の左右バンクにそれぞれ可変バルブ機構(可変バルブタイミング機構及び/又は可変バルブリフト機構)を設けた可変バルブシステムに本発明を適用したものである。つまり、V型内燃機関の左右バンクにそれぞれ可変バルブ機構を設けたシステムにおいて、吸入空気量や吸気管圧の変化に基づいて異常診断を行う場合、異常診断しないバンク側の可変バルブ機構が作動していると、その影響で、他方のバンク側の吸入空気量や吸気管圧力が変動してしまい、正確な異常診断をすることができない。

【0053】そこで、本実施形態(4)では、図6に示す異常診断プログラムを所定時間毎に実行することで、V型内燃機関の左右バンクにそれぞれ可変バルブ機構を設けたシステムにおける異常診断を次のようにして行う。

【0054】まず、ステップ401で、左バンクの可変バルブ機構の異常診断要求が有るか否かを判定し、左バンクの可変バルブ機構の異常診断要求が有れば、ステップ402に進み、異常診断しない右バンクの可変バルブ機構を固定して、右バンクの可変バルブ機構の作動による吸入空気量や吸気管圧力の変動を無くし、次のステップ403で、左バンクの可変バルブ機構の異常診断を前記実施形態と同様の方法で実行する。この後、ステップ404に進み、異常診断を終了して左バンクの可変バル

ブ機構を通常の制御に戻し、次のステップ405で、右バンクの可変バルブ機構の固定を解除して通常の制御に戻し、本プログラムを終了する。

【0055】一方、ステップ401で、左バンクの可変バルブ機構の異常診断要求が無ければ、ステップ406に進み、右バンクの可変バルブ機構の異常診断要求が有るか否かを判定する。右バンクの可変バルブ機構の異常診断要求が有れば、異常診断しない左バンクの可変バルブ機構を固定して、左バンクの可変バルブ機構の作動による吸入空気量や吸気管圧力の変動を無くす(ステップ407)。その後、左バンク側と同じ方法で右バンクの可変バルブ機構の異常診断を実行する(ステップ408)。その後、異常診断を終了して右バンクの可変バルブ機構を通常の制御に戻し(ステップ409)、左バンクの可変バルブ機構の固定を解除して通常の制御に戻し(ステップ410)、本プログラムを終了する。

【0056】このようにすれば、V型内燃機関の左右バンクにそれぞれ可変バルブ機構を設けた可変バルブシステムにおいて、異常診断しないバンク側の可変バルブ機構の作動による吸気パラメータの変化を無くして、異常診断するバンク側の可変バルブ機構の作動による吸気パラメータの変化のみを取り出すことができ、異常診断しないバンク側の可変バルブ機構の影響を全く受けずに、異常診断を精度良く行うことができる。

【図面の簡単な説明】

【図1】本発明の実施形態(1)におけるシステム全体の概略構成を示す図

【図2】実施形態(1)における異常診断プログラムの処理の流れを示すフローチャート

【図3】本発明の実施形態(2)における異常診断プログラムの処理の流れを示すフローチャート

【図4】本発明の実施形態(3)における異常診断プログラムの処理の流れを示すフローチャート

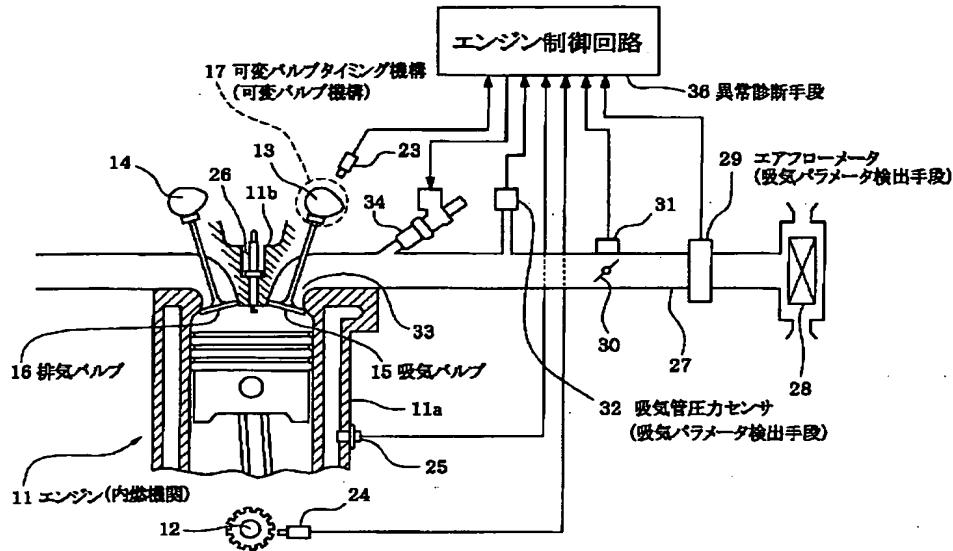
【図5】本発明の実施形態(4)における異常診断プログラムの処理の流れを示すフローチャート

【図6】本発明の実施形態(5)における異常診断プログラムの処理の流れを示すフローチャート

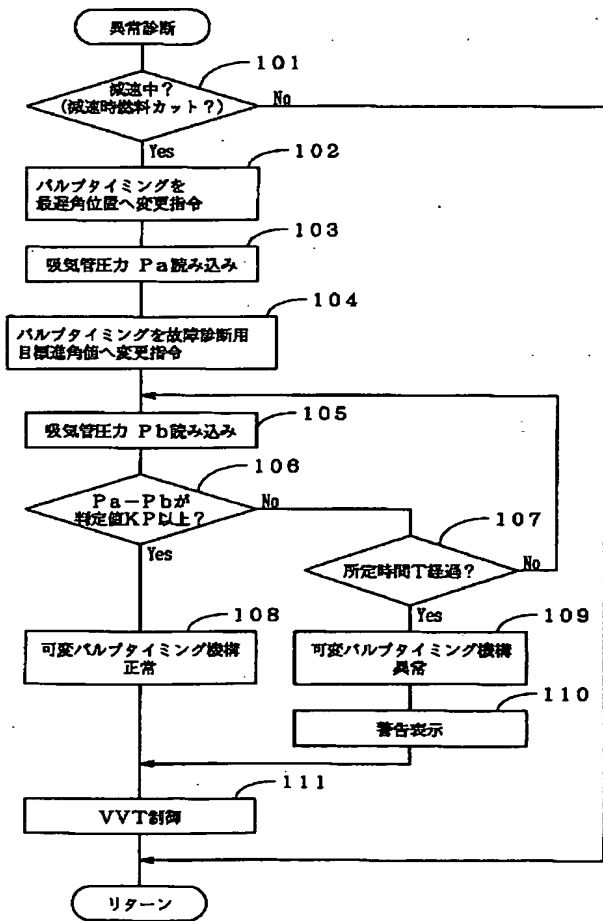
【符号の説明】

11…エンジン(内燃機関)、12…クランク軸、13…吸気カム軸、14…排気カム軸、15…吸気バルブ、16…排気バルブ、17…可変バルブタイミング機構(可変バルブ機構)、23…カム軸センサ、24…クランク軸センサ、29…エアフローメータ(吸気パラメータ検出手段)、32…吸気管圧力センサ(吸気パラメータ検出手段)、36…ECU(異常診断手段)。

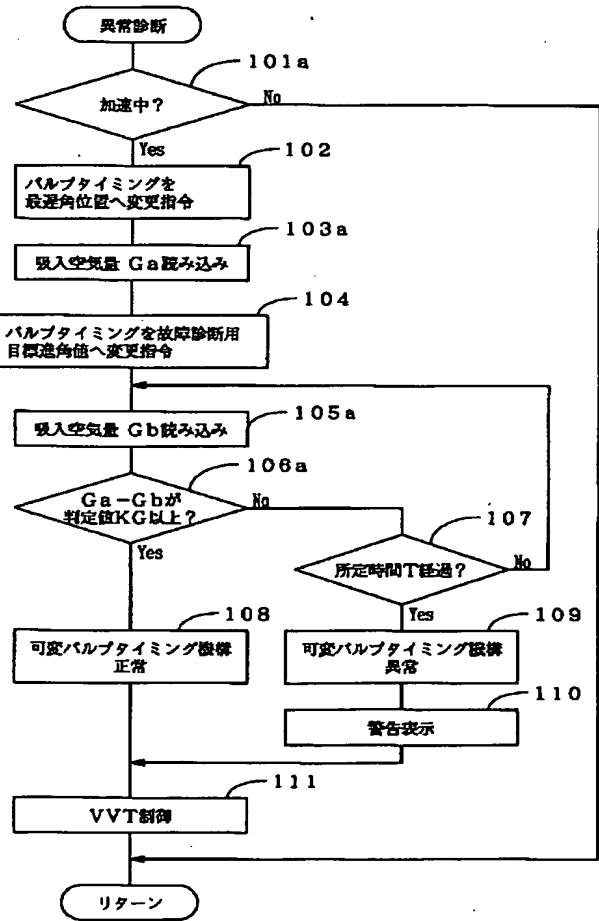
【図 1】



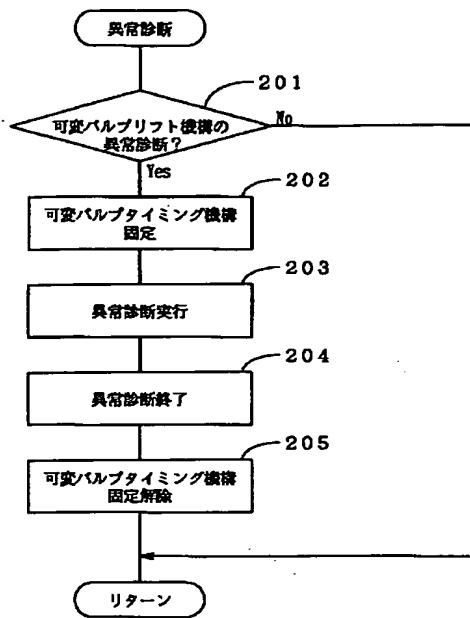
【図 2】



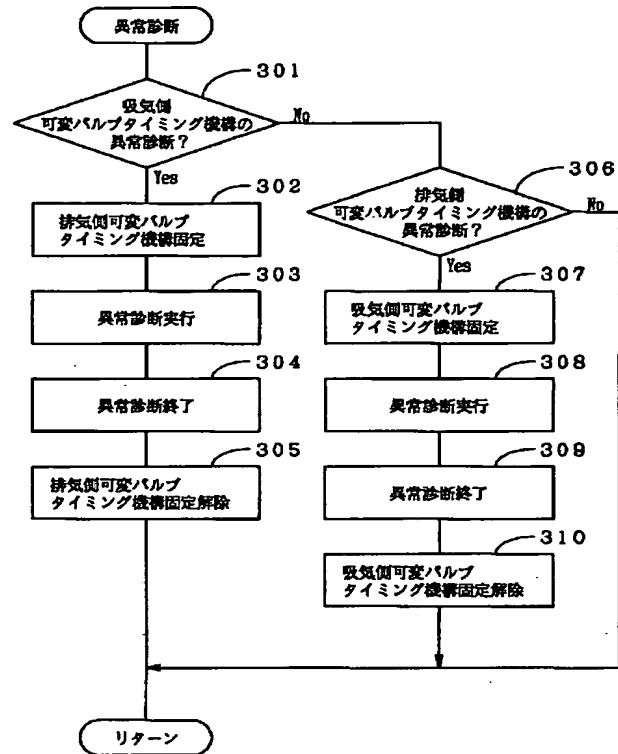
【図 3】



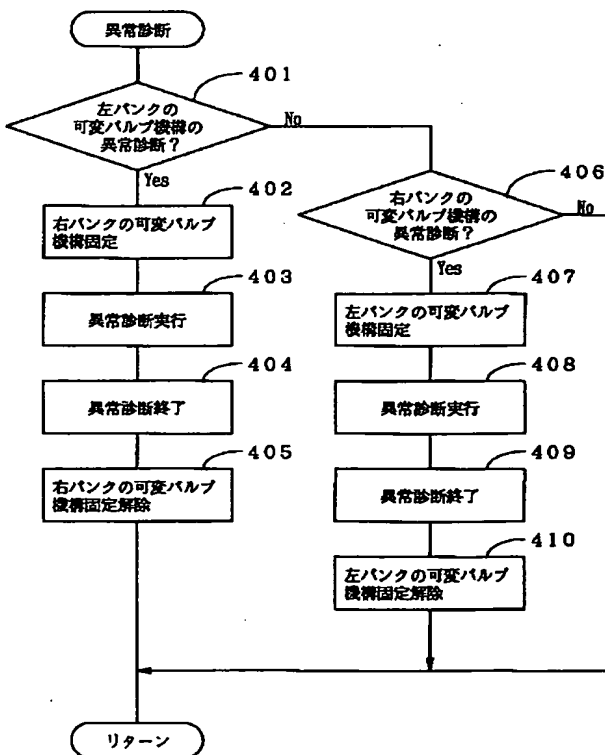
【図 4】



【図 5】



【図 6】



フロントページの続き

(51)Int.Cl. ⁷	識別記号	F I	ターマコード* (参考)
F 0 2 D 45/00	3 6 6	F 0 2 D 45/00	3 6 6 H
F ターム (参考)			
3G084	BA23 DA10 DA27 EB11 FA07 FA10 FA11 FA13 FA20		
3G092	AA05 AA11 DA01 DA02 DA03 EA03 EA08 EA13 EA15 EA17 EB09 EC01 FA03 FA15 FA44 FB03 FB06 GA12 GA13 HA02Z HA05Z HA07Z HA13X HA13Z HB01Z HE08Z		
3G301	HA19 JA03 JA21 JB02 JB09 JB10 KA12 KA16 LA03 LA07 LB02 ND01 NE11 NE16 NE23 PA02Z PA08Z PA12Z PB03Z PE08Z PE10A PE10Z		

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The adjustable valve mechanism which carries out adjustable control of an internal combustion engine's valve timing or amount of valve lifts, An inhalation-of-air parameter appearance means to detect said internal combustion engine's inhalation air content or pressure-of-induction-pipe force, It has an abnormality diagnostic means to perform an abnormality diagnosis of said adjustable valve mechanism based on the detection value change of said inhalation-of-air parameter appearance means when operating said adjustable valve mechanism compulsorily using the control value for an abnormality diagnosis. Said abnormality diagnostic means is the abnormality diagnostic equipment of the adjustable bulb system characterized by performing an abnormality diagnosis when said internal combustion engine's operational status is except a steady state.

[Claim 2] The adjustable valve timing device which carries out adjustable control of an internal combustion engine's valve timing, The adjustable valve-lift device which carries out adjustable control of said internal combustion engine's amount of valve lifts, An inhalation-of-air parameter appearance means to detect said internal combustion engine's inhalation air content or pressure-of-induction-pipe force, One device of said adjustable valve timing device and said adjustable valve-lift devices is fixed. Abnormality diagnostic equipment of the adjustable bulb system characterized by having an abnormality diagnostic means to perform an abnormality diagnosis of the device of the another side concerned based on the detection value change of said inhalation-of-air parameter appearance means when operating the device of another side compulsorily using the control value for an abnormality diagnosis.

[Claim 3] The inspired air flow path adjustable valve mechanism which carries out adjustable control of at least the valve timing of an internal combustion engine's intake valve, and one side of the amount of valve lifts, The exhaust side adjustable valve mechanism which carries out adjustable control of at least the valve timing of said internal combustion engine's exhaust air bulb, and one side of the amount of valve lifts, An inhalation-of-air parameter appearance means to detect said internal combustion engine's inhalation air content or pressure-of-induction-pipe force, One adjustable valve mechanism of said inspired air flow path adjustable valve mechanism and said exhaust side adjustable valve mechanisms is fixed. When operating the adjustable valve mechanism of another side compulsorily using the control value for an abnormality diagnosis Abnormality diagnostic equipment of the adjustable bulb system characterized by having an abnormality diagnostic means to perform an abnormality diagnosis of the adjustable valve mechanism of the another side concerned based on the detection value change of a ***** inhalation-of-air parameter appearance means.

[Claim 4] Said abnormality diagnostic means is the abnormality diagnostic equipment of the adjustable bulb system according to claim 2 or 3 characterized by performing an abnormality diagnosis when said internal combustion engine's operational status is except a steady state.

[Claim 5] The adjustable valve mechanism formed in a V type internal combustion engine's right-and-left bank, respectively, An inhalation-of-air parameter appearance means to detect said internal combustion engine's inhalation air content or pressure-of-induction-pipe force, The adjustable valve mechanism of one bank of said right-and-left banks is fixed. When operating the adjustable valve mechanism of a bank of another side compulsorily using the control value for an abnormality diagnosis Abnormality diagnostic equipment of the adjustable bulb system characterized by having an abnormality diagnostic means to perform an abnormality diagnosis of the adjustable valve mechanism of a bank of the another side concerned based on the detection value change of a ***** inhalation-of-air parameter appearance means.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the abnormality diagnostic equipment of an adjustable bulb system which diagnoses the existence of the abnormalities of the adjustable valve mechanism which carries out adjustable control of at least an internal combustion engine's valve timing and one side of the amount of valve lifts.

[0002]

[Description of the Prior Art] In recent years, in the internal combustion engine carried in a car, what adopted the adjustable valve timing device for the purpose of the improvement in an output, fuel consumption reduction, and exhaust air emission reduction is increasing. and as shown in JP,6-317118,A for an abnormality diagnosis of this adjustable valve timing device, valve timing is compulsorily changed at the time of the steady state from which an engine operation condition serves as about 1 law by low rotation (1500 - 2000rpm) and the low load, the variation of the inhalation air content at that time is detected, and there are some which diagnosed the existence of the abnormalities of an adjustable valve timing device as compared with the decision value about this inhalation air variation.

[0003]

[Problem(s) to be Solved by the Invention] although valve timing is changed compulsorily and it is made to perform an abnormality diagnosis from the variation of an inhalation air content in the above-mentioned official report when an engine operation condition is a steady state of about 1 law, changing an inhalation air content compulsorily at the time of a steady state will mean changing compulsorily the engine operation condition which was stable till then to a transient, and it will cause aggravation of drivability or emission. But if variation (change of an inhalation air content) of valve timing is lessened in order to lessen drivability at the time of an abnormality diagnosis, and aggravation of emission, the difference at the time of always [forward] and abnormalities cannot become small, and an abnormality diagnosis cannot be performed with a sufficient precision. Therefore, in order to improve abnormality accuracy, it is necessary to enlarge variation (change of an inhalation air content) of valve timing to some extent.

[0004] Although there are some which adopted the adjustable valve-lift device which carries out adjustable [of the amount of valve lifts] by the type of a car of recent years part, if change of an inhalation air content is lessened in order for a situation not to change but to lessen effect of the drivability and emission on [at the time of an abnormality diagnosis] also with this adjustable valve-lift device, an abnormality diagnosis cannot be performed with a sufficient precision. In the following explanation, an adjustable valve timing device and an adjustable valve-lift device are named generically, and it is called a "adjustable valve mechanism."

[0005] Moreover, by recently, the engine which carried the adjustable valve timing device in both the inspired air flow path and the exhaust side, and the engine which carried both the adjustable valve timing device and the adjustable valve-lift device are considered. Although these engines can also consider performing an abnormality diagnosis from change of an inhalation air content, if the adjustable valve mechanism of another side is operating while performing the abnormality diagnosis of one adjustable valve mechanism, by actuation of the adjustable valve mechanism of the another side concerned, an inhalation air content cannot change and an exact abnormality diagnosis cannot be performed.

[0006] This invention is made in consideration of these situations. The 1st purpose In the system which performs an abnormality diagnosis of an adjustable valve mechanism based on change of inhalation-of-air parameters, such as an inhalation air content It is in offering the abnormality diagnostic equipment of an adjustable bulb system which can perform an abnormality diagnosis with a sufficient precision, lessening effect on drivability or emission. Moreover, the 2nd purpose is in the internal combustion engine carrying two or more adjustable valve mechanisms to offer the abnormality diagnostic equipment of an adjustable bulb system which can perform an abnormality diagnosis of an adjustable valve mechanism with a sufficient precision based on change of inhalation-of-air parameters, such as an inhalation air content.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the abnormality diagnostic equipment of the adjustable bulb system of claim 1 of this invention While it has the adjustable valve mechanism which carries out adjustable control of an internal combustion engine's valve timing or amount of valve lifts and an inhalation-of-air parameter appearance means detects an internal combustion engine's inhalation air content or pressure-of-induction-pipe force Based on change of the detection value (an inhalation air content or pressure-of-induction-pipe force) of the inhalation-of-air parameter appearance means when operating an adjustable valve mechanism compulsorily using the control value for an abnormality diagnosis, the existence of the abnormalities of an adjustable valve mechanism is diagnosed with an abnormality diagnostic means. Under the present circumstances, an abnormality diagnostic means performs an abnormality diagnosis, when an internal combustion engine's operational status is except a steady state. [0008] At the time of a transient like an acceleration condition or a moderation condition, since an inhalation-of-air parameter (an inhalation air content, pressure-of-induction-pipe force) also changes according to operational status, even if [when operational status is except a steady state, for example,] it changes an inhalation-of-air parameter further at this period for an abnormality diagnosis, there is little effect on drivability or emission as compared with the case where an inhalation-of-air parameter is changed from a steady state like before. Therefore, if an abnormality diagnosis is performed when operational status is except a steady state, lessening effect on drivability or emission, valve timing at the time of an abnormality diagnosis or variation of the amount of valve lifts can be enlarged to some extent, change of the inhalation-of-air parameter used for an abnormality diagnosis can be enlarged, and the improvement in abnormality accuracy and drivability emission aggravation prevention can be reconciled.

[0009] Moreover, like claim 2, when performing an abnormality diagnosis based on change of an inhalation-of-air parameter in the internal combustion engine having both an adjustable valve timing device and an adjustable valve-lift device, it is good to be made to perform an abnormality diagnosis of the device of the another side concerned based on change of the inhalation-of-air parameter when

fixing one device of an adjustable valve timing device and the adjustable valve-lift devices, and operating the device of another side compulsorily using the control value for a diagnosis. If it does in this way, in the internal combustion engine having both an adjustable valve timing device and an adjustable valve-lift device, change of the inhalation-of-air parameter by the actuation of a near adjustable valve mechanism which does not carry out an abnormality diagnosis can be lost, only change of the inhalation-of-air parameter by the actuation of a near adjustable valve mechanism which carries out an abnormality diagnosis can be taken out, and an abnormality diagnosis can be performed with a sufficient precision, without being influenced [which does not carry out an abnormality diagnosis] at all of a near adjustable valve mechanism.

[0010] Moreover, it sets like claim 3 to the internal combustion engine which equipped both the intake valve and the exhaust air bulb with the adjustable valve mechanism (an adjustable valve timing device and/or adjustable valve-lift device). In performing an abnormality diagnosis based on change of an inhalation-of-air parameter It is good to be made to perform an abnormality diagnosis of the valve mechanism of the another side concerned based on change of the inhalation-of-air parameter when fixing one adjustable valve mechanism of an inspired air flow path adjustable valve mechanism and the exhaust side adjustable valve mechanisms, and operating the adjustable valve mechanism of another side compulsorily using the control value for a diagnosis. If it does in this way, change of the inhalation-of-air parameter by actuation of the adjustable valve mechanism by the side of the bulb which does not carry out an abnormality diagnosis can lose, only change of the inhalation-of-air parameter by actuation of the adjustable valve mechanism by the side of the bulb which carries out an abnormality diagnosis can take out, and an abnormality diagnosis can carry out with a sufficient precision in the internal combustion engine which equipped both the intake valve and the exhaust-air bulb with the adjustable valve mechanism, without being influenced at all of the adjustable valve mechanism by the side of the bulb which does not carry out an abnormality diagnosis.

[0011] Furthermore, also in the internal combustion engine which carried two or more adjustable valve mechanisms like claims 2 and 3 mentioned above, like claim 4, when an internal combustion engine's operational status is except a steady state, it is desirable to perform an abnormality diagnosis of an adjustable valve mechanism. If it does in this way, the aggravation prevention of drivability emission and the improvement in abnormality accuracy at the time of an abnormality diagnosis can be reconciled as well as claim 1 mentioned above.

[0012] Moreover, in the adjustable bulb system which formed the adjustable valve mechanism in a V type internal combustion engine's right-and-left bank, respectively, it is good to be made to perform an abnormality diagnosis of the adjustable valve mechanism of a bank of the another side concerned based on the detection value change of the inhalation-of-air parameter appearance means when fixing the adjustable valve mechanism of one bank of the right-and-left banks, and operating the adjustable valve mechanism of a bank of another side compulsorily like claim 5, using the control value for an abnormality diagnosis. If it does in this way, change of the inhalation-of-air parameter by actuation of the adjustable valve mechanism by the side of the bank which does not carry out an abnormality diagnosis can lose, only change of the inhalation-of-air parameter by actuation of the adjustable valve mechanism by the side of the bank which carries out an abnormality diagnosis can take out, and an abnormality diagnosis can carry out with a sufficient precision in the adjustable bulb system which formed an adjustable valve mechanism in a V type internal combustion engine's right-and-left bank, respectively, without winning popularity at all in the effect of the adjustable valve mechanism by the side of the bank which does not carry out an abnormality diagnosis.

[0013]

[Embodiment of the Invention] The operation gestalt (1) of this invention is explained based on drawing 1 and drawing 2 below [an operation gestalt (1)]. First, the outline configuration of the whole system is explained based on drawing 1. The engine 11 which is an internal combustion engine is a DOHC engine, transmits the power of a crankshaft 12 to the air inlet cam shaft 13 and the exhaust cam shaft 14 through a timing chain (not shown), and carries out the closing motion drive of an intake valve 15 and the exhaust air bulb 16 with each cam shafts 13 and 14. The adjustable valve timing device 17 of the hydraulic-drive type which adjusts the amount of tooth lead angles of the air inlet cam shaft 13 over a crankshaft 12 is formed in the air inlet cam shaft 13. Moreover, the cam shaft sensor 23 is installed near the air inlet cam shaft 13, and the crankshaft sensor 24 is installed near the crankshaft 12.

[0014] In this case, the cam shaft sensor 23 generates a 2-N piece [per rotation of the air inlet cam shaft 13] cam shaft phase detection pulse signal to the crankshaft sensor 24 generating the crankshaft phase detection pulse signal of N individual per rotation of a crankshaft 12. Moreover, when the amount of the maximum tooth lead angles of the air inlet cam shaft 13 is set to the θ_{\max} degree-CA, the number N of crankshaft phase detection pulse signals is set up so that it may be set to $N < 360/\theta_{\max}$. The real valve timing (the amount of real tooth lead angles of the air inlet cam shaft 13) of an intake valve 15 is computed by this by the angular strain between the crankshaft phase detection pulse signal from the crankshaft sensor 24, and the cam shaft phase detection pulse signal from the air inlet cam shaft sensor 23 generated following this.

[0015] Moreover, the cooling coolant temperature sensor 25 which detects cooling water temperature is attached in cylinder block 11a of an engine 11, and the ignition plug 26 is attached in cylinder head 11b for every gas column.

[0016] On the other hand, an air cleaner 28 is formed in the maximum upstream section of an inlet pipe 27, and the air flow meter 29 which detects an inhalation air content is formed in the downstream at it. A throttle valve 30 is formed in the downstream of this air flow meter 29, and the opening (throttle opening) of this throttle valve 30 is detected by the throttle sensor 31. The pressure-of-induction-pipe force sensor 32 which detects the pressure-of-induction-pipe force is formed in the downstream of this throttle valve 30. Moreover, the fuel injection valve 34 is attached near the suction port 33 of each gas column.

[0017] The output of various kinds of sensors mentioned above is inputted into the engine control circuit (it is written as "ECU" below) 36. This ECU36 calculates the target valve timing (the amount of target tooth lead angles of the air inlet cam shaft 13) of an intake valve 15 based on the various sensor outputs which detect an engine operation condition while it is constituted considering a microcomputer as a subject and calculates the real valve timing of an intake valve 15 based on the detection pulse signal from the crankshaft sensor 24 and the cam shaft sensor 23.

[0018] Moreover, ECU36 performs adjustable valve timing control (it is written as "VVT control" below) which controls a hydraulic control valve (not shown) and carries out feedback control of the adjustable valve timing device 17 so that the real valve timing of an intake valve 15 may be made in agreement with target valve timing.

[0019] Furthermore, ECU36 is performing the abnormality diagnostic program shown in drawing 2 for every predetermined time, and functions as an abnormality diagnostic means to perform an abnormality diagnosis of the adjustable valve timing device 17 during the times other than a steady state, for example, moderation. Hereafter, the contents of processing of the abnormality diagnostic program of drawing 2 are explained. If this program is started, it will judge first whether it is under [moderation] ***** as an abnormality diagnostic execution condition at step 101. This judgment is judged by whether it is under [fuel cut] ***** for example, at the time of moderation. If judged with it not being under moderation at step 101, an abnormality diagnostic execution condition will become abortive and this program will be ended, without performing subsequent abnormality diagnostic processes (steps 102-111).

[0020] On the other hand, when judged with under moderation at step 101, an abnormality diagnostic execution condition is satisfied,

and even if it changes valve timing compulsorily, it judges that there is little effect affect drivability and emission, and the abnormality diagnostic process after step 102 is carried out as follows.

[0021] First, at step 102, the valve timing of an intake valve 15 is compulsorily returned to the maximum lag location, and the pressure-of-induction-pipe force Pa in case the valve timing of an intake valve 15 is in the maximum lag location is read from the detecting signal of the pressure-of-induction-pipe force sensor 32 by the following step 103. In this case, the pressure-of-induction-pipe force sensor 32 functions as an inhalation-of-air parameter appearance means as used in the field of a claim.

[0022] Then, at step 104, tooth-lead-angle control of the valve timing of an intake valve 15 is compulsorily carried out to the target tooth-lead-angle value for an abnormality diagnosis, and the pressure-of-induction-pipe force is changed. Then, the pressure-of-induction-pipe force Pb detected by the pressure-of-induction-pipe force sensor 32 is read at step 105, and it judges whether the variation (Pa-Pb) of the pressure-of-induction-pipe force is beyond the decision value KP at the following step 106. Under the present circumstances, a decision value KP may use the fixed value set up beforehand, and may set up a decision value KP by the map or the function expression according to an engine operation condition.

[0023] If the variation (Pa-Pb) of the pressure-of-induction-pipe force is smaller than a decision value KP, it will progress to step 107 and will judge whether predetermined time T passed. Here, predetermined time T is set as time amount [a little] longer than the maximum time amount of forward always after ordering it modification to the target tooth-lead-angle value of valve timing until the variation (Pa-Pb) of the pressure-of-induction-pipe force becomes beyond a decision value KP, in order to take into consideration the actuation delay of the adjustable valve timing device 17 of forward always. Therefore, if the adjustable valve timing device 17 is normal, the variation (Pa-Pb) of the pressure-of-induction-pipe force will become beyond with the decision value KP within predetermined time T.

[0024] Whenever it is judged with the variation (Pa-Pb) of the pressure-of-induction-pipe force being smaller than a decision value KP before predetermined time T progress, processing of step 105,106 mentioned above is repeated and performed. And if judged with the variation (Pa-Pb) of the pressure-of-induction-pipe force having become at step 106 beyond the decision value KP by the time predetermined time T passed, it progresses to step 108, and the adjustable valve timing device 17 will judge with it being normal, and will progress to step 111, it will return to the usual VVT control, and this program will be ended.

[0025] On the other hand, when predetermined time T passes without judging the variation (Pa-Pb) of the pressure-of-induction-pipe force at step 106 to be beyond the predetermined value KP, the adjustable valve timing device 17 judges that it is not operating normally, and progresses to step 109, and it judges with the adjustable valve timing device 17 being unusual. In this case, it is the following step 110, and after turning on or blinking a warning lamp (not shown) and telling an operator about the abnormalities of the adjustable valve timing device 17, it progresses to step 111, it returns to the usual VVT control, and this program is ended.

[0026] According to the operation gestalt (1) explained above, during moderation Since the effect affect drivability and emission was made to perform an abnormality diagnosis during moderation paying attention to the point of being few even if it changed valve timing compulsorily Without causing aggravation of drivability or emission at the time of an abnormality diagnosis, the target tooth-lead-angle value for an abnormality diagnosis can be set up somewhat greatly, variation of the pressure-of-induction-pipe force used for an abnormality diagnosis can be enlarged, and the difference of the variation of the pressure-of-induction-pipe force at the time of always [forward] and abnormalities can be enlarged. Thereby, abnormality accuracy can be raised, preventing aggravation of the drivability emission at the time of an abnormality diagnosis.

[0027] moreover – this operation gestalt (1) – under moderation – the direction of the pressure-of-induction-pipe force – an inhalation air content – the effect of valve timing change – a receptacle – easy – since the variation of the pressure-of-induction-pipe force is used as an inhalation-of-air parameter for an abnormality diagnosis paying attention to variation becoming large, the difference of the variation of the pressure-of-induction-pipe force at the time of always [forward] and abnormalities can be enlarged more, and an abnormality diagnosis can be carried out with a more sufficient precision.

[0028] However, this invention is replaced with the pressure-of-induction-pipe force, and it may be made to use the variation of an inhalation air content as an inhalation-of-air parameter for an abnormality diagnosis, and even in this case, if an abnormality diagnosis is performed during moderation, since the target tooth-lead-angle value for an abnormality diagnosis can be set up somewhat greatly, without causing aggravation of drivability or emission, the variation of an inhalation air content required to perform an abnormality diagnosis can be obtained.

[0029] In addition, although the judgment under moderation was judged by whether it is under [fuel cut] ***** at the time of moderation, you may make it judge with this operation gestalt (1) based on the decrement of accelerator opening, the decrement of throttle opening, the decrement of fuel oil consumption, etc.

[0030] With the [operation gestalt (2)] above-mentioned implementation gestalt (1), although it was made to perform an abnormality diagnosis during moderation, even if it changes valve timing compulsorily during acceleration, the effect affect drivability and emission is made to perform an abnormality diagnosis during acceleration with the operation gestalt (2) of this invention shown in drawing 3 paying attention to few things. furthermore – this operation gestalt (2) – under acceleration – the direction of an inhalation air content – the pressure-of-induction-pipe force – the effect of valve timing change – a receptacle – easy – paying attention to variation becoming large, the variation of an inhalation air content is used as an inhalation-of-air parameter for an abnormality diagnosis.

[0031] With the abnormality diagnostic program of drawing 3 performed with this operation gestalt (2), it judges first whether it is under [acceleration] ***** as an abnormality diagnostic execution condition by step 101a. This judgment is judged based on the augend of for example, accelerator opening, the augend of throttle opening, the augend of fuel oil consumption, etc.

[0032] When judged with under acceleration (abnormality diagnostic execution condition formation) by step 101a, even if it changes valve timing compulsorily, it judges that there is little effect affect drivability and emission, and it progresses with steps 102 and 103a, and the inhalation air content Ga when returning the valve timing of an intake valve 15 to the maximum lag location is read from the detecting signal of an air flow meter 29. In this case, an air flow meter 29 functions as an inhalation-of-air parameter appearance means as used in the field of a claim.

[0033] Then, at step 104, tooth-lead-angle control of the valve timing of an intake valve 15 is compulsorily carried out to the target tooth-lead-angle value for an abnormality diagnosis, an inhalation air content is changed, and the inhalation air content Gb detected with the air flow meter 29 by the following step 105a is read. Then, the variation (Ga-Gb) of an inhalation air content judges whether it is beyond the decision value KG by step 106a.

[0034] And when predetermined time T passes without judging with the adjustable valve timing device 17 being normal, returning to the usual VVT control, and the variation (Ga-Gb) of an inhalation air content becoming beyond the decision value KG, if the variation (Ga-Gb) of an inhalation air content will become beyond the decision value KG by the time it does predetermined time T progress of, it judges with the adjustable valve timing device 17 being unusual, an alarm display is carried out, and it returns to the usual VVT control (steps 107-111).

[0035] Also in this operation gestalt (2) explained above, the same effectiveness as said operation gestalt (1) can be acquired. In addition, with the above-mentioned operation gestalt (2), although the variation of an inhalation air content was used as an inhalation-of-air parameter for an abnormality diagnosis, the variation of the pressure-of-induction-pipe force may be used.

[0036] Moreover, although each above-mentioned operation gestalt (1) and (2) apply this invention to an abnormality diagnosis of the adjustable valve timing device 17 of an intake valve 15, they may apply this invention to an abnormality diagnosis of the adjustable valve timing device of an exhaust air bulb, and the adjustable valve-lift device in which the amount of lifts of an intake valve or an exhaust air bulb is changed.

[0037] [An operation gestalt (3)], next the operation gestalt (3) of this invention are explained using drawing 4. In addition to the system configuration of said operation gestalt (1), with this operation gestalt (3), the adjustable valve-lift device (not shown) in which the amount of lifts of an intake valve 15 is adjusted is established.

[0038] Thus, it sets to the system equipped with both the adjustable valve timing device 17 and the adjustable valve-lift device to one intake valve 15. When performing an abnormality diagnosis based on change of an inhalation air content or the pressure of induction pipe, for example, even if it carries out lift control of the adjustable valve-lift device compulsorily to the target lift value for an abnormality diagnosis. If the adjustable valve timing device 17 is operating, an inhalation air content and the pressure-of-induction-pipe force are changed under the effect, and an exact abnormality diagnosis cannot be carried out.

[0039] So, this operation gestalt (3) performs an abnormality diagnosis of the adjustable valve-lift device in the system equipped with the adjustable valve timing device 17 and the adjustable valve-lift device as follows by performing the abnormality diagnostic program shown in drawing 4 for every predetermined time.

[0040] First, this program will be ended, if it judges whether there is any abnormality diagnostic demand of an adjustable valve-lift device at step 201 and there is no abnormality diagnostic demand of an adjustable valve-lift device. Then, when an abnormality diagnostic demand of an adjustable valve-lift device occurs, the adjustable valve timing device 17 which progresses to step 202 and does not carry out an abnormality diagnosis is fixed to a current tooth-lead-angle value, and fluctuation of the inhalation air content by actuation of the adjustable valve timing device 17 or the pressure-of-induction-pipe force is lost.

[0041] Then, it progresses to step 203 and an abnormality diagnosis of an adjustable valve-lift device is performed. This abnormality diagnosis changes the amount of lifts of an intake valve 15 compulsorily to the target lift value for an abnormality diagnosis, and judges the existence of abnormalities by measuring the inhalation air content at that time, or the variation of the pressure-of-induction-pipe force with an abnormality decision value. It progresses to step 204 after an abnormality judging, and an abnormality diagnosis is ended, an adjustable valve-lift device is usually returned to control, at the following step 205, immobilization of the adjustable valve timing device 17 is canceled, it returns to the usual VVT control, and this program is ended.

[0042] If it does in this way, an abnormality diagnosis can be carried out based on the inhalation air content which lost fluctuation of the inhalation air content by the actuation of the adjustable valve timing device 17 which does not carry out an abnormality diagnosis, or the pressure-of-induction-pipe force, and reflected only the actuation of an adjustable valve-lift device which carries out an abnormality diagnosis, or the variation of the pressure-of-induction-pipe force. Consequently, in the system equipped with both the adjustable valve timing device 17 and the adjustable valve-lift device, it becomes possible to perform an accurate abnormality diagnosis.

[0043] In addition, what is necessary is just to make it fix an adjustable valve-lift device, when performing an abnormality diagnosis of the adjustable valve timing device 17. Moreover, although this invention was applied to the system which equipped the intake valve 15 with both the adjustable valve timing device 17 and the adjustable valve-lift device with the above-mentioned operation gestalt (3), it is applicable also to the system which equipped the exhaust air bulb 16 with both the adjustable valve timing device and the adjustable valve-lift device.

[0044] [An operation gestalt (4)], next the operation gestalt (4) of this invention are explained using drawing 5. In addition to the system configuration of said operation gestalt (1), with this operation gestalt (4), the exhaust side adjustable valve timing device (not shown) in which the valve timing of the exhaust air bulb 16 is changed is established.

[0045] In the system which equipped both the intake valve 15 and the exhaust air bulb 16 with the adjustable valve timing device, if the adjustable valve timing device by the side of the bulb which does not carry out an abnormality diagnosis is operating when performing an abnormality diagnosis based on change of an inhalation air content or the pressure of induction pipe, an inhalation air content and the pressure-of-induction-pipe force are changed under the effect, and an exact abnormality diagnosis cannot be carried out.

[0046] So, this operation gestalt (4) performs as follows the abnormality diagnosis in the system which equipped both the intake valve 15 and the exhaust air bulb 16 with the adjustable valve timing device by performing the abnormality diagnostic program shown in drawing 5 for every predetermined time.

[0047] First, the exhaust-side adjustable valve-timing device which will progress to step 302 and will not carry out the abnormality diagnosis of whether there is any abnormality diagnostic demand of the inspired air flow path adjustable valve timing device 17 if it judges and there is an abnormality diagnostic demand of the inspired air flow path adjustable valve timing device 17 is fixed at step 301, fluctuation of the inhalation air content by actuation of an exhaust side adjustable valve timing device or the pressure-of-induction-pipe force is lost, and an abnormality diagnosis of the inspired air flow path adjustable valve-timing device 17 is performed at the following step 303. This abnormality diagnosis performs an abnormality diagnosis as well as said operation gestalt (1) or (2) based on change of the inhalation air content when carrying out the tooth lead angle of the inspired air flow path adjustable valve timing device 17 compulsorily from the maximum lag location to the target tooth-lead-angle value for an abnormality diagnosis, or change of the pressure of induction pipe. It progresses to step 304 after an abnormality judging, and an abnormality diagnosis is ended, the inspired air flow path adjustable valve timing device 17 is returned to the usual VVT control, at the following step 305, immobilization of an exhaust side adjustable valve timing device is canceled, it returns to the usual VVT control, and this program is ended.

[0048] It judges whether on the other hand, at step 301, if there is no abnormality diagnostic demand of the inspired air flow path adjustable valve-lift device 17, it progresses to step 306 and there is any abnormality diagnostic demand of an exhaust side adjustable valve timing device. If there is an abnormality diagnostic demand of an exhaust side adjustable valve timing device, the inspired air flow path adjustable valve timing device 17 which does not carry out an abnormality diagnosis will be fixed, and fluctuation of the inhalation air content by actuation of the inspired air flow path adjustable valve timing device 17 or the pressure-of-induction-pipe force will be lost (step 307). Then, an abnormality diagnosis of an exhaust side adjustable valve timing device is performed by the same approach as an inspired air flow path (step 308), after an abnormality judging, an abnormality diagnosis is ended, an exhaust side adjustable valve timing device is returned to the usual VVT control (step 309), immobilization of the inspired air flow path adjustable valve timing device 17 is canceled, it returns to the usual VVT control (step 310), and this program is ended.

[0049] Fluctuation of the inhalation air content by actuation of the adjustable valve-timing device by the side of the bulb which will

not carry out an abnormality diagnosis if it does in this way, or the pressure-of-induction-pipe force loses, and an abnormality diagnosis can perform based on the variation of the inhalation air content only reflecting actuation of the adjustable valve-timing device by the side of the bulb which carries out an abnormality diagnosis, or the variation of the pressure-of-induction-pipe force, and it becomes that it is possible to perform an accurate abnormality diagnosis also in the system which equipped both an intake valve and an exhaust-air bulb with an adjustable valve mechanism.

[0050] In addition, although this invention was applied to the system which equipped the intake valve 15 and the exhaust air bulb 16 with the adjustable valve timing device with the above-mentioned operation gestalt (4), it is applicable also to the system which equipped the intake valve 15 and the exhaust air bulb 16 with the adjustable valve timing device and/or the adjustable valve-lift device.

[0051] Moreover, it may be made to carry out an abnormality diagnosis of said operation gestalt (3) and (4) as well as said operation gestalt (1) and (2) at the times other than a steady state (under acceleration and moderation). If it does in this way, the drivability and emission at the time of an abnormality diagnosis can also improve.

[0052] [An operation gestalt (5)], next the operation gestalt (5) of this invention are explained using drawing 6. This operation gestalt (5) applies this invention to the adjustable bulb system which formed the adjustable valve mechanism (an adjustable valve timing device and/or adjustable valve-lift device) in a V type internal combustion engine's right-and-left bank, respectively. That is, in the system which formed the adjustable valve mechanism in a V type internal combustion engine's right-and-left bank, respectively, if the adjustable valve mechanism by the side of the bank which does not carry out an abnormality diagnosis is operating when performing an abnormality diagnosis based on change of an inhalation air content or the pressure of induction pipe, under the effect, the inhalation air content and pressure-of-induction-pipe force by the side of a bank of another side are changed, and an exact abnormality diagnosis cannot be carried out.

[0053] So, this operation gestalt (4) performs as follows the abnormality diagnosis in the system which formed the adjustable valve mechanism in a V type internal combustion engine's right-and-left bank, respectively by performing the abnormality diagnostic program shown in drawing 6 for every predetermined time.

[0054] First, if it judges whether there is any abnormality diagnostic demand of the adjustable valve mechanism of a left bank and there is an abnormality diagnostic demand of the adjustable valve mechanism of a left bank at step 401. The adjustable valve mechanism of the right bank which does not progress and carry out an abnormality diagnosis is fixed to step 402, fluctuation of the inhalation air content by actuation of the adjustable valve mechanism of a right bank or the pressure-of-induction-pipe force is lost, and an abnormality diagnosis of the adjustable valve mechanism of a left bank is performed by the same approach as said operation gestalt at the following step 403. Then, it progresses to step 404 and an abnormality diagnosis is ended, the adjustable valve mechanism of a left bank is returned to the usual control, at the following step 405, immobilization of the adjustable valve mechanism of a right bank is canceled, it returns to the usual control, and this program is ended.

[0055] It judges whether on the other hand, at step 401, if there is no abnormality diagnostic demand of the adjustable valve mechanism of a left bank, it progresses to step 406 and there is any abnormality diagnostic demand of the adjustable valve mechanism of a right bank. If there is an abnormality diagnostic demand of the adjustable valve mechanism of a right bank, the adjustable valve mechanism of the left bank which does not carry out an abnormality diagnosis will be fixed, and fluctuation of the inhalation air content by actuation of the adjustable valve mechanism of a left bank or the pressure-of-induction-pipe force will be lost (step 407). Then, an abnormality diagnosis of the adjustable valve mechanism of a right bank is performed by the same approach as a left bank side (step 408). Then, an abnormality diagnosis is ended, the adjustable valve mechanism of a right bank is returned to the usual control (step 409), and immobilization of the adjustable valve mechanism of a left bank is canceled, it returns to the usual control (step 410), and this program is ended.

[0056] If it does in this way, change of the inhalation-of-air parameter by actuation of the adjustable valve mechanism by the side of the bank which does not carry out an abnormality diagnosis can lose, only change of the inhalation-of-air parameter by actuation of the adjustable valve mechanism by the side of the bank which carries out an abnormality diagnosis can take out, and an abnormality diagnosis can carry out with a sufficient precision in the adjustable bulb system which formed an adjustable valve mechanism in a V type internal combustion engine's right-and-left bank, respectively, without winning popularity at all in the effect of the adjustable valve mechanism by the side of the bank which does not carry out an abnormality diagnosis.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] Drawing showing the outline configuration of the whole system in the operation gestalt (1) of this invention

[Drawing 2] The flow chart which shows the flow of processing of the abnormality diagnostic program in an operation gestalt (1)

[Drawing 3] The flow chart which shows the flow of processing of the abnormality diagnostic program in the operation gestalt (2) of this invention

[Drawing 4] The flow chart which shows the flow of processing of the abnormality diagnostic program in the operation gestalt (3) of this invention

[Drawing 5] The flow chart which shows the flow of processing of the abnormality diagnostic program in the operation gestalt (4) of this invention

[Drawing 6] The flow chart which shows the flow of processing of the abnormality diagnostic program in the operation gestalt (5) of this invention

[Description of Notations]

11 [-- An exhaust cam shaft, 15 / -- An intake valve, 16 / -- An exhaust air bulb, 17 / -- An adjustable valve timing device (adjustable valve mechanism), 23 / -- A cam shaft sensor, 24 / -- A crankshaft sensor, 29 / -- An air flow meter (inhalation-of-air parameter appearance means), 32 / -- A pressure-of-induction-pipe force sensor (inhalation-of-air parameter appearance means), 36 / -- ECU (abnormality diagnostic means).] -- An engine (internal combustion engine), 12 -- A crankshaft, 13 -- An air inlet cam shaft, 14

[Translation done.]

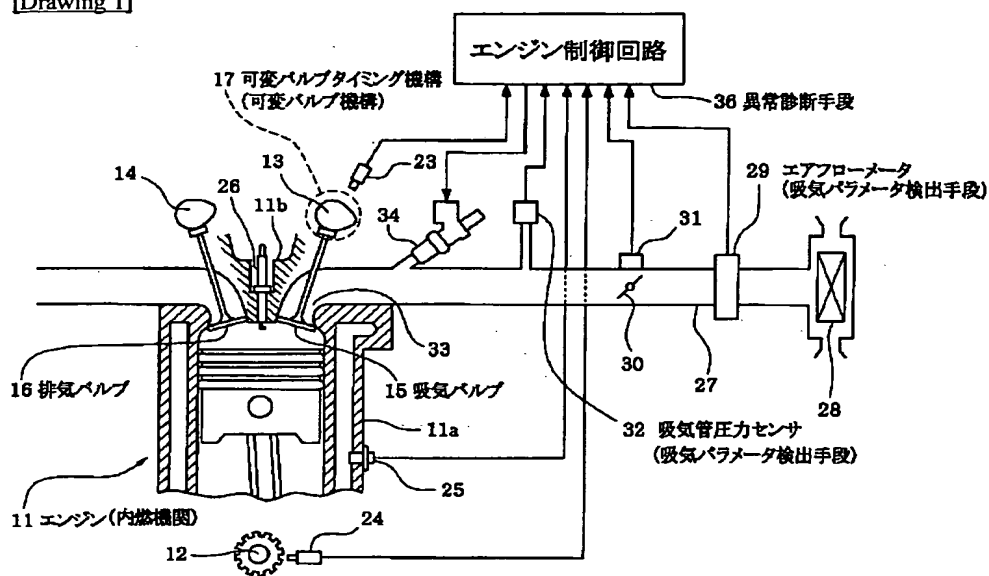
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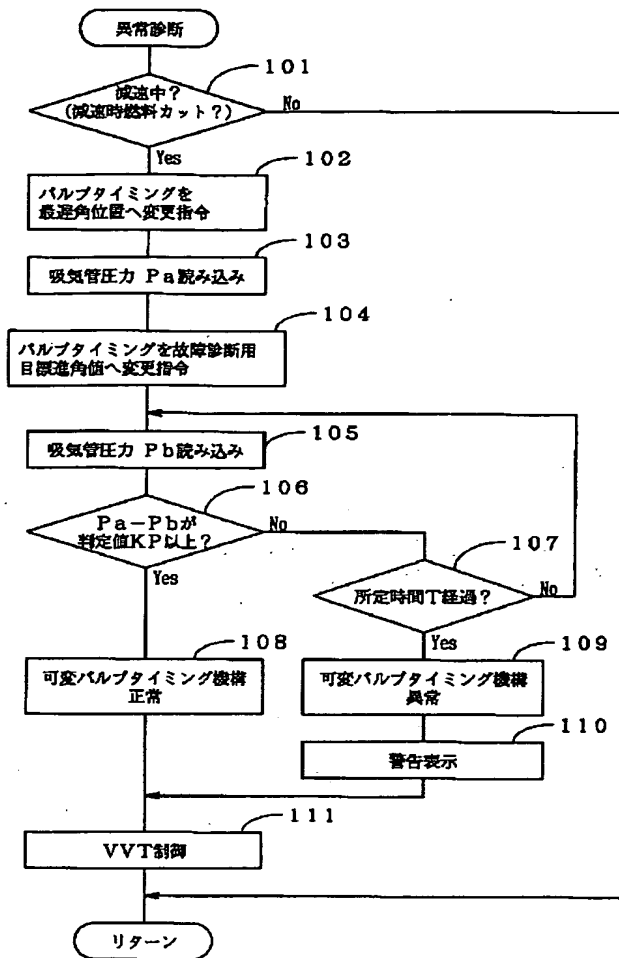
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DRAWINGS

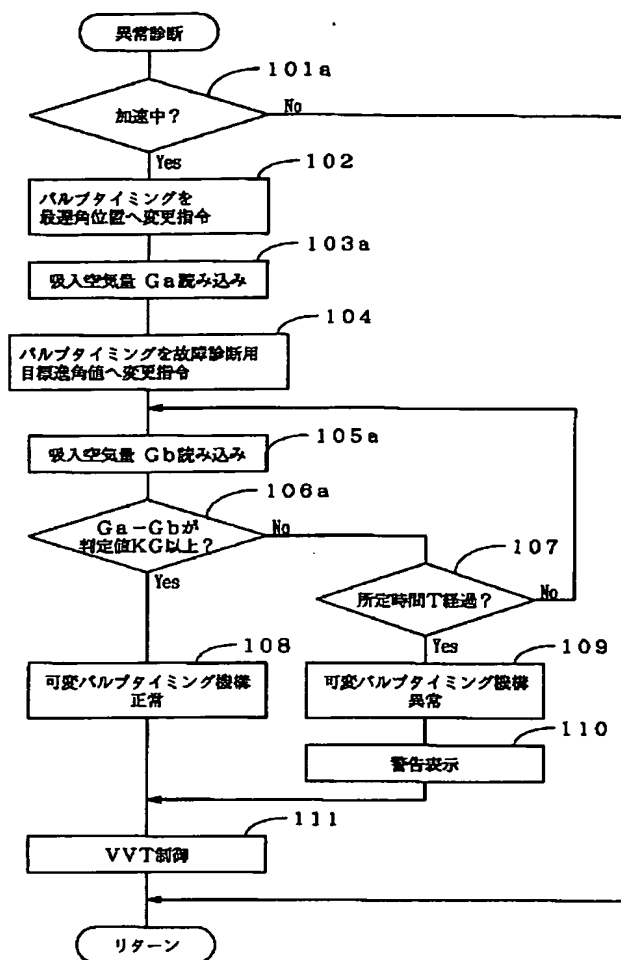
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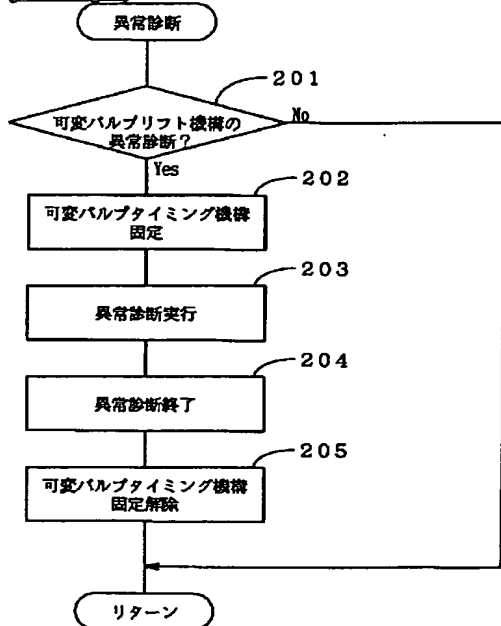
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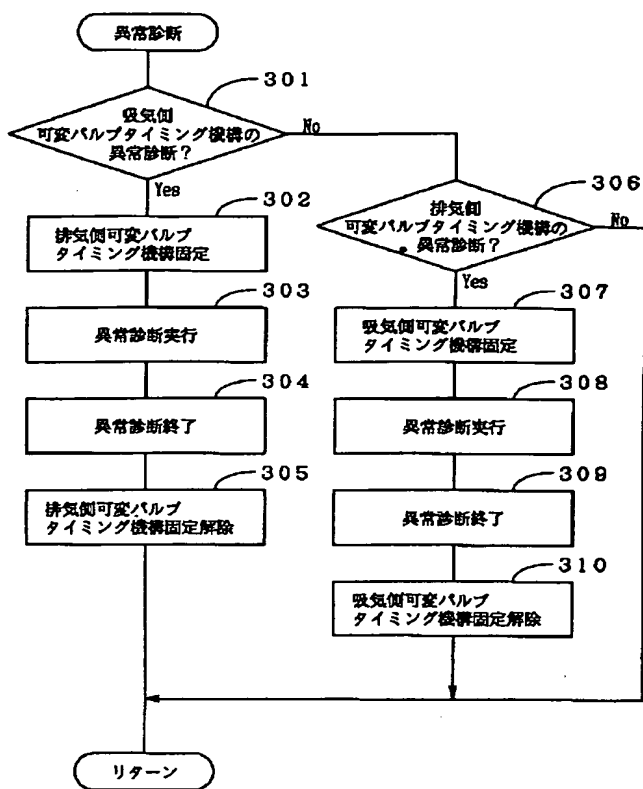
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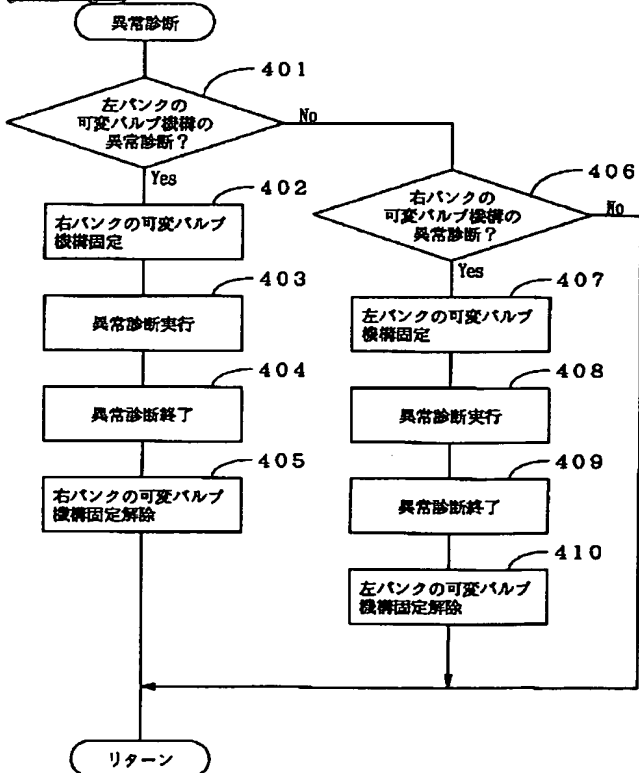
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]